

CLAIMS:

1. Apparatus (40; 60; 80; 90) for processing an input signal ($S_{RF}(t)$) having a carrier frequency (ω_{RF}) that defines a desired band and at least a side band having a side band frequency ($n\omega_{LO}$) that is higher than the carrier frequency (ω_{RF}), the apparatus (40; 60; 80; 90) comprising
 - 5 - a main input (50; 70; 79; 92) for receiving said input signal ($S_{RF}(t)$),
 - a first mixer (41; 61) having a first mixer input (44; 64), a first local oscillator input (47; 67), and a first mixer output (A), the first mixer input (44; 64) being connectable to the main input (50; 70; 79; 92) and the first local oscillator input (47; 67) being connectable to a source (86, 10 87; 93) providing a first local oscillator signal (LO1) having a frequency (ω_{LO}) close to or equal to the carrier frequency (ω_{RF}), the first mixer (41; 61) performing a multiplication of said input signal ($S_{RF}(t)$) and said first local oscillator signal (LO1) to provide a first output signal ($S_A(t)$) at the first mixer output (A),
 - 15 the apparatus (40; 60; 80; 90) being characterized in that it further comprises
 - at least a second mixer (42; 62) having a second mixer input (45; 65), a second local oscillator input (48; 68), and a second mixer output (B), the second mixer input (45; 65) being connectable to the main input (50; 70; 79; 92) and the second local oscillator input (48; 68) being connectable to a source (86, 87; 94) providing a second local oscillator signal (LO2) 20 having the sideband frequency ($n\omega_{LO}$), the second mixer (42; 62) performing a multiplication of said input signal ($S_{RF}(t)$) and said second local oscillator signal (LO2) to provide a second output signal ($S_B(t)$) at the second mixer output (B),
 - 25 - means for performing a superpositioning of the first output signal ($S_A(t)$) and the second output signal ($S_B(t)$),

the first local oscillator signal (LO1) and the second local oscillator signal (LO2) being square wave signals.

2. Apparatus (40; 60; 80; 90) as claimed in claim 1, wherein the second
5 mixer (42; 62) applies a negative or a positive coefficient ($1/3$; $-1/3$; $1/n$; $-1/n$) when performing the multiplication of said input signal ($S_{RF}(t)$) and said second local oscillator signal (LO2).
3. Apparatus (40; 60; 80; 90) as claimed in claim 1 or 2, wherein the means
10 for performing a superpositioning of the first output signal and the second output signal ($S_B(t)$) are realized as an adder (51; 71).
4. Apparatus (40; 60; 80; 90) as claimed in claim 1, 2 or 3, wherein the
desired band carries an information signal, preferably digital data, modulated on the
15 carrier signal with the carrier frequency (ω_{RF}).
5. Apparatus (40; 60; 80; 90) as claimed in one of the preceding claims,
wherein the side band frequency ($n\omega_{LO}$) is an odd harmonic of the carrier frequency
(ω_{RF}).
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6. Apparatus (40; 60; 80; 90) as claimed in one of the preceding claims,
further comprising a low-pass filter (LPF; 52; 72; 85) at the output side of the apparatus
(40; 60; 80; 90).
- 25 7. Apparatus (40; 60; 80; 90) as claimed in one of the preceding claims,
wherein, in order to avoid direct feedthrough, the output of the apparatus (40; 60; 80;
90) is sensed as a differential signal.
8. Apparatus (40; 60; 80; 90) as claimed in one of the preceding claims,
30 wherein the period (T1) of the first local oscillator signal (LO1) and the period (T2) of
the second local oscillator signal (LO2) have the following relationship: $T2 = T1/3$.

9. Apparatus (40; 60; 80; 90) as claimed in one of the preceding claims,
wherein the first local oscillator signal (LO1) and the second local oscillator signal
5 (LO2) have zero phase at $t=0$.

10. Apparatus (60; 80; 90) as claimed in one of the claims 1 through 8,
wherein the first local oscillator signal (LO1) and the second local oscillator signal
(LO2) have quadrature phases.

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11. Apparatus (40; 60; 80; 90) as claimed in one of the preceding claims,
wherein the square waves have a 50% duty cycle.

12. Method of processing an input signal ($S_{RF}(t)$) having a carrier frequency
15 (ω_{RF}) defining a desired band and at least one sideband frequency ($n\omega_{LO}$) defining a
sideband, where the sideband frequency ($n\omega_{LO}$) is higher than the carrier frequency
(ω_{RF}), the method comprising the steps of:

- receiving said input signal ($S_{RF}(t)$),
- providing a first local oscillator signal (LO1) having a frequency (ω_{LO})
20 close to or equal to the carrier frequency (ω_{RF}),
- performing a multiplication of said input signal ($S_{RF}(t)$) with said first
local oscillator signal (LO1) in order to provide a first output signal ($S_A(t)$),
- providing a second local oscillator signal (LO2) with the sideband
25 frequency ($n\omega_{LO}$)
- performing a multiplication of said input signal ($S_{RF}(t)$) and said second
local oscillator signal (LO2) in order to provide a second output signal
($S_B(t)$),
- performing a superpositioning of the first output signal ($S_A(t)$) and the
30 second output signal ($S_B(t)$),
wherein the first local oscillator signal (LO1) and the second local

oscillator signal (LO2) are square-wave signals.

13. Method as claimed in claim 12, wherein a negative or a positive coefficient ($1/3$; $-1/3$; $1/n$; $-1/n$) is applied when performing the multiplication of said
5 input signal ($S_{RF}(t)$) and said second local oscillator signal (LO2).
14. Method as claimed in claim 12 or 13, wherein the superpositioning is performed by means of an adder (51; 71).
- 10 15. Method as claimed in claim 12, 13 or 14, wherein the desired band carries an information signal, preferably digital data, modulated on the carrier signal with the carrier frequency (ω_{RF}).
16. Method as claimed in one of the claims 12 through 15, wherein the
15 sideband frequency ($n\omega_{LO}$) is an odd harmonic of the carrier frequency (ω_{RF}).
17. Method as claimed in one of the claims 12 through 16, using a low-pass filter (LPF; 52; 72; 85) at the output side.
- 20 18. Method as claimed in one of the claims 12 through 17, wherein the output is sensed as a differential signal.
19. Method of one of the claims 12 through 18, wherein the period (T1) of the first local oscillator signal (LO1) and the period (T2) of the second local oscillator
25 signal (LO2) have the following relationship: $T2 = T1/3$.
20. Method as claimed in one of the claims 12 through 19, wherein the first local oscillator signal (LO1) and the second local oscillator signal (LO2) have zero
phase at $t=0$.
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21. Method as claimed in one of the claims 12 through 19, wherein the first

local oscillator signal (LO1) and the second local oscillator signal (LO2) have quadrature phases.

22. Method as claimed in one of the claims 12 through 21, wherein the
5 square waves have a 50% duty cycle.

23. Receiver, preferably a heterodyne radio frequency receiver, comprising
an apparatus (40; 60; 80; 90) according to one of the claims 1 through 11, said apparatus
(40; 60; 80; 90) being part of a chain of circuits (82, 83, 85, 89) that processes the input
10 signal ($S_{RF}(t)$) to convert it to a low-frequency intermediate-frequency signal ($S_{IF}(t)$).

24. Receiver as claimed in claim 23, being part of a Global System for
Mobile communication (GSM) system, a Blue tooth system, or a Universal Mobile
Telephony System.